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SAFETY APPARATUS AGAINST AUTOMOBILE CLASH

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates to a safety apparatus against an automobile clash, wherein A head of a driver or passenger is recognized, thereby controlling a safety unit, e.g., controlling an unfolding of an air bag.

2. Description of the Related Art

The unfolding of the air bag is controlled, for example, depending upon a kind of a driver and passengers, e.g., adult. or child. Further, a person's head is recognized on the basis of a face image extracted by a flesh color image picked up by a color area image sensor.

Further, the person's head is detected by face features.

However, it is not easy to identify the head on the basis of the flesh color, due to great differences thereof.

Further, it is not also easy to identify the head on the basis of shape patterns such as eyes, nose, ears. This is because glasses and mask disturb the head identification and the image processing becomes complicated, when the face directs obliquely toward the area image sensor, thereby greatly changing the details of the face shape patterns.

SUMMARY OF THE INVENTION

An object of the present invention is to identify a driver or passenger in order to control an air bag unfolding at a car clash.

Another object of the present invention is to avoid a complicated image processing for identifying a head recognition.

The safety apparatus against automobile clash comprises: at least one area image sensor for picking up an image of a passenger (possibly including a driver); passenger information extracting means for extracting a passenger information, e.g., adult or child; and a safety unit control means for controlling an operation of a safety unit against an automobile clash (e.g., an air bag).

The passenger information extracting means stores beforehand closed shape images expressing every possible kinds of passenger's head profile who may possibly take a ride. The passenger information is determined by comparing the closed outlines extracted from the picked-up image which are supposedly passenger's head with the references. The determination result is inputted into the safety control unit, thereby controlling the safety unit.

The passenger's head is extracted on the basis of the outlines of the passenger's head. The head outline shape is in general nearly an ellipse. Further, the head is rotated around the ellipse's major axis which is held almost along the vertical axis. Therefore, the head outline shape is changed little by an individual difference and head

direction. Accordingly, a memory load for reference images is low and a load for image processing for extracting the head ellipse is also low, thereby reducing an image processing time period and improving an accuracy of the passenger determination. The safety apparatus against automobile clash of the present invention is superior in a point of view of a rapid control of such a safety unit as an air bag, because the passenger recognition is more rapidly and accurately completed than conventional determinations by such other facial shapes as eyes, nose and mouth. Further, the present invention is more advantageous than the conventional passenger recognition, because glasses and a mask hide less part of the head, compared with the eyes, nose, or mouth, thereby degrading little the determination accuracy.

In the present invention, the passenger's information is determined on the basis of a closed curve a part of which is an ellipse.

Therefore, according to the present invention, the two dimensional patterns of the reference head images and detected head image are simplified, thereby simplifying storing and processing the images. Further, such simple curve as an ellipse is parametrized, thereby further simplifying the image processing.

BRIEF EXPLANATION OF THE DRAWINGS

FIG. 1 is a conceptual block diagram of the safety

apparatus against an automobile clash of the present invention.

FIG. 2 is a flow chart for deciding a kind of a passenger (including a driver, assistant driver and other passenger(s)), e.g., adult or child, thereby controlling an unfolding of an air bag of the safety apparatus against an automobile clash as shown in FIG. 1.

FIG. 3 shows a future processing region (including a detected head ellipse) designated for detecting the head ellipse at a next time to come, thereby simply and rapidly detecting the present passenger, even when the present passenger once moved outside the future processing region.

FIG. 4 is a plan view of the passenger's seat around which one more area image sensor is provided.

FIG. 5 is another arrangement of the image sensors.

FIG. 6 is a still another arrangement of the area image sensors.

FIG. 7 is a modified version of the flow chart as shown in FIG. 2.

FIG. 8 is a conceptual block diagram of the safety apparatus of the present invention provided with a stereo range finder.

PREFERRED EMBODIMENT OF THE INVENTION

A preferred embodiment and its modifications are explained, referring to the drawings.

FIG. 1 is a conceptual block diagram of the safety

apparatus against a car clash of the present invention, wherein imaging means 1 (such as an area image sensor, e.g., CCD) is fixed at an upper lateral side of a automobile body 2 in order to pick up an image of an assistance driver on an assistance driver's seat 3. Concretely, the area image sensor 1 looks down the upper space of a seat 3 and outputs the picked-up image to an image processing unit 5. The image signal is a sequentially outputted raster scan signal which constructs a two dimensional frame signal. The safety apparatus further comprises: an A/D converter 4 for converting the output from the area image sensor 1; and an air bag control unit 6 connected with the output terminal of the image processing unit.

The image sensor 1 preferably is highly sensitive to the infrared spectrum region, thereby being able to photograph even at a dark place or night time.

The image processing unit 5: receives a the A/D converted frame signal; stores it in a frame memory in order to reduce its noises, to emphasize outlines in it and to digitize the signal by two bits; and processing it for a decision of passenger kind, e.g., adult or child, male or female. In place of using the A/C converter 4, the output from the area image sensor 1 may be digitized at two bits and inputted into the image processing unit 5. Further, the output from the area image sensor 1 may be emphasized on the horizontal and vertical outlines and inputted into the image processing unit 5. Further, the area sensor 1 itself may outputs two bit digital signals.

Further, a part of or all of the image processing unit 5 may be constructed by a single hardware. Further, not two bit signals, but multi-bit signals, e.g., eight bit signals may be inputted into the image processing unit 5 in order to improve a quality and accuracy of the image processing .

The image processing unit 5: extracts a passenger's head information (adult or child, male or female, or its location along the front-rear direction of the automobile, its location along the left-light direction, and even present or absent); and outputs it to an air bag control unit 6 which control the unfolding of the air bag on the basis of the head information.

FIG. 2 is a flow chart for deciding a passenger kind. The passenger decision is executed by a micro-computer or a high speed hardware exclusively used for that purpose.

First, a boundary between two regions different in brightness in the two-dimensional image space at S100. The boundary in general includes a plurality of closed loop or outlines.

Next, elliptic boundaries are extracted among the boundaries at S102. The elliptic boundaries are determined by curvature changes along a boundary, or by a change in distances between a center of the points on the boundary. The elliptic boundaries can be easily detected by smoothing the boundaries as picked up by the area sensor 1. Further, the curvature of the boundary can be detected by coordinates of three points distant by a prescribed distance with each other. However, other

known local curvature decision methods may be employed. Thus, the boundaries with a prescribed curvature change proper to the ellipse are easily found.

Next, an ellipse supposedly expressing a head is detected at S104. The ellipse shape of the detected head ellipse is such that the shape may belong to a shape range of reference ellipses stored beforehand. Thus, shapes and sizes which are elliptic but not deemed to be heads are excluded. Here, the detected head ellipse may be stored in a form of a two dimensional pattern or a parameter expression by a major axis, minor axis, a center coordinate, inclination of the major axis and ellipticity.

If a head ellipse was not detected at S106, it is determined and outputted a fact that there is no passenger and S100 follows. On the contrary, if a head ellipse was detected at S106, S110 follows.

Then, if the detected head ellipse is determined to be approximately the same as one of the reference head ellipses, that reference head ellipse is decided to be a head ellipse candidate of the passenger. On the contrary, if the detected head ellipse is not approximately the same as any of the reference head ellipses, S108 follows, thereby returning back to S100.

Further, at S112, a kind of the passenger, e.g., adult or child, is decided on the basis of the head ellipse candidate and the decided kind is outputted to the air bag controll unit 6. Or rather, it may happen to be decided on merely the presence or absence of the passenger at S112.

Next, the image region surrounding the detected head ellipse is decided at S114 to be a future process region processed at a time to come by S100 to S110. The size of the future process region is set up in such a manner that the passenger's head at the time to come will possibly be allowed within the set-up future processing region, even if the present passenger once exited outside the set-up future processing region. FIG. 3 shows the future processing region 30 (in the two dimensional scan region 32). The detected head ellipse 31 is surrounded by the future processing region 30.

Next, The detected head ellipse is newly registered as a reference head ellipse at S116, thereby comparing at a first priority the newly registered reference head ellipse with a passenger's head at a future recognition. Thus, the future processing time period is effectively reduced. Here, the detected head ellipse may be inclined or rotated for the new registration.

According to the above explained safety apparatus, the head image processing can be executed rapidly, without lowering a determination accuracy, because the passenger kind is determined by a head ellipse whereby a viewing angle is relevant little, an individual difference is small and therefore, an analysis is easy.

Modified Embodiment 1

Boundaries without a passenger are extracted from a

frame image and are stored beforehand. Then, the stored boundaries are subtracted from a frame image with a passenger and executes S102 for extracting an ellipse. Thus, the image noise is effectively removed.

Modified Embodiment 2

Deformed head outlines with hat, cap or special hair style are registered for the reference head ellipses. Thus, the determination accuracy is improved. Further, lower head portions irrelevant to the hat, cap or special hair style may be employed as the reference head ellipses.

Modified Embodiment 3

The reference head ellipses are learned by inputting model images into the area image sensor 1. The learning results may be stored in ROM.

Modified Embodiment 4

The passenger's head often moves right and left, thereby changing the head ellipse size. Therefore, the detected head ellipse may be enlarged or reduced on the basis of a measured actual distance between the head and area image sensor 1. The enlargement or reduction may be executed merely by correcting the ellipse parameters.

FIG. 4 is a plan view of the passenger's (driver's, or

assistant driver's) seat 3, around which another area image sensor 11 as well as the area image sensor 1 are disposed distant by a prescribed distance along the front-rear direction, thereby measuring the actual distance between the passenger's head 50 and sensors 1 and 11 by using the stereo range finding method. The area sensors 1 and 11 are used both for the passenger determination and distance measurement.

Modified Embodiment 5

The passenger's physical condition may be known by a height of the detected head ellipse, thereby determining, e.g., whether the passenger is adult or child.

Modified Embodiment 6

A distance between the head and air bag is calculated on the basis of a head position along the front-rear direction, because the area image sensor 1 is disposed at a lateral side of the passenger's seat. Thus, the air bag unfolding is controlled on the basis of the head-bag distance.

Modified Embodiment 7

FIG. 5 shows another arrangement of two image sensors 1 and 11, wherein the passenger's seat 3 is between

those sensors. On the basis of the center position of head ellipse detected by the area image sensors 1 and 11: a center position of the head ellipse along the right-left direction is calculated; a distance between the head and area image sensors 1 and 11 is calculated on the basis of the calculated center position; and the size of the detected head ellipse is enlarged or reduced on the basis of the calculated distance.

The determination accuracy is not lowered, even when the passenger rotates his or her head, because the area sensor 1 n and 11 independently determines the passenger kind.

Modified Embodiment 8

FIG. 6 shows still another sensor arrangement, wherein the area image sensor 1 is disposed at a lateral side of the passenger's seat, while another area image sensor 11 is disposed at a rear of the seat 3. The image size of the area sensor 11 is corrected on the basis of the position along the front-rear direction obtained by the area image sensor 1, while the image size of the area sensor 1 is corrected on the basis of the position along the right-left direction obtained by the area image sensor 11. Thus, the determination accuracy is further improved.

The determination accuracy is not lowered, even when the passenger rotates his or her head, because the area sensor 1 and 11 independently determines the passenger

kind. The shoulder width of the passenger is further measured by the area image sensor 11, thereby knowing more accurately the passenger's physical conditions.

Modified Embodiment 9

FIG. 7 is a modified version of the flow chart as shown in FIG. 2 for the passenger determination.

If there is not found any head ellipse, boundary extraction is further continuously executed all over the two dimensional scan region 32 at S118 as shown in FIG. 7 (S100-S104 as shown in FIG. 2). If a head ellipse is detected, then, S110 as shown in FIG. 2 is executed for finding a head ellipse candidate. On the contrary, if any head ellipse is not detected at S118, then, S108 follows for outputting a fact that no passenger is seated. I may be scheduled to search all over the two dimensional scan region 32 at a time to come, if any head ellipse is not detected in the future processing region 30.

Thus, the head ellipse can be detected, even when it does not exist within the future processing region.

Modified Embodiment 10

FIG. 8 is another conceptual block diagram of the safety apparatus against automobile clash of the present invention. In place of the area image sensor 1, a stereo range finder comprising area sensors 100 and 110 for head

detection and head-air bag distance measurement.

Modified Embodiment 11

In addition to the above mentioned range finder, another area sensor may be provides, thereby enlarges or reducing a picked-up image in accordance with a position of the passenger's head measured by the range finder.